Space Weather Technical Forecast

Issued on Sunday, 15 October 2023 at 13:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 Minor Storms, mainly day 2 and 4 (16/18 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak flare C3.5 at 15/1632 UTC from AR3467 in the northeast. There are six numbered sunspot regions. The most notable growth was from AR3464 in the centre disc which has developed a small penumbral trailer spot. Slight growth has also been observed in AR3466 in the northwest, however this remains a small, simple region. Otherwise, slight decay is evident in AR3460, losing penumbra within its trailer, and AR3463 which continues to see its small spots fade. AR3465 and AR3467, both in the northeast show little development, although the latter is slightly more complex due to its location within a broad plage area.

One potentially Earth-directed CME was observed. This was associated with a dimming event and observed filament channel in EUV from immediate north of AR3466 at 14/1240UTC, around N15W25. This has the potential to give a glancing arrival on day 4 (18 Oct) either alongside, or combined with the previous CME which was observed earlier on 14 Oct. A further filament eruption to the west of CH60/+ occurred off the southwest disc. This was visible in H-alpha at 15/1004 UTC with an associated filament channel in EUV, but no associated coronagraph imagery is currently available to assess any resultant CME.

Further events of interest included a low solar latitude disappearing filament (dsf) which has not produced an analysable CME signal, while a broad CME to the southwest has been attributed to a far-side eruption.

Solar Wind / Geomagnetic Activity: CH58/- fast winds eased. Solar winds speeds measured by ACE at L1 declined from slightly elevated to be near background, from 500 km/s to around 400 km/s. Density was average to below average. The total interplanetary magnetic field (IMF), Bt, was weak, below 5nT, with the north-south component, Bz, ranging weakly between +4 and -2nT, but predominately positive (northward). Phi angle was largely indeterminate. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background. GOES16 high energy (greater than 2MeV) electron flux was at Background. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 15/0000 UTC was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity expected at first with only small and relatively simple sunspots on the visible disc. The main potential for increasing activity is from AR3464 in the central disc. Activity has the potential to increase later in the period as any new regions rotate onto the disc, with an increasing chance of M-flares.

Solar Wind / Geomagnetic Activity: There are two potential CME arrivals giving a glancing impact early on 18 Oct, likely combined as a single event. These are from the CMEs produced by the dimming event and observed filament channel around N15W25 at 14/1240 UTC, and also a corona-based dimming around N35W030 starting around 14/0340UTC. Otherwise, the main

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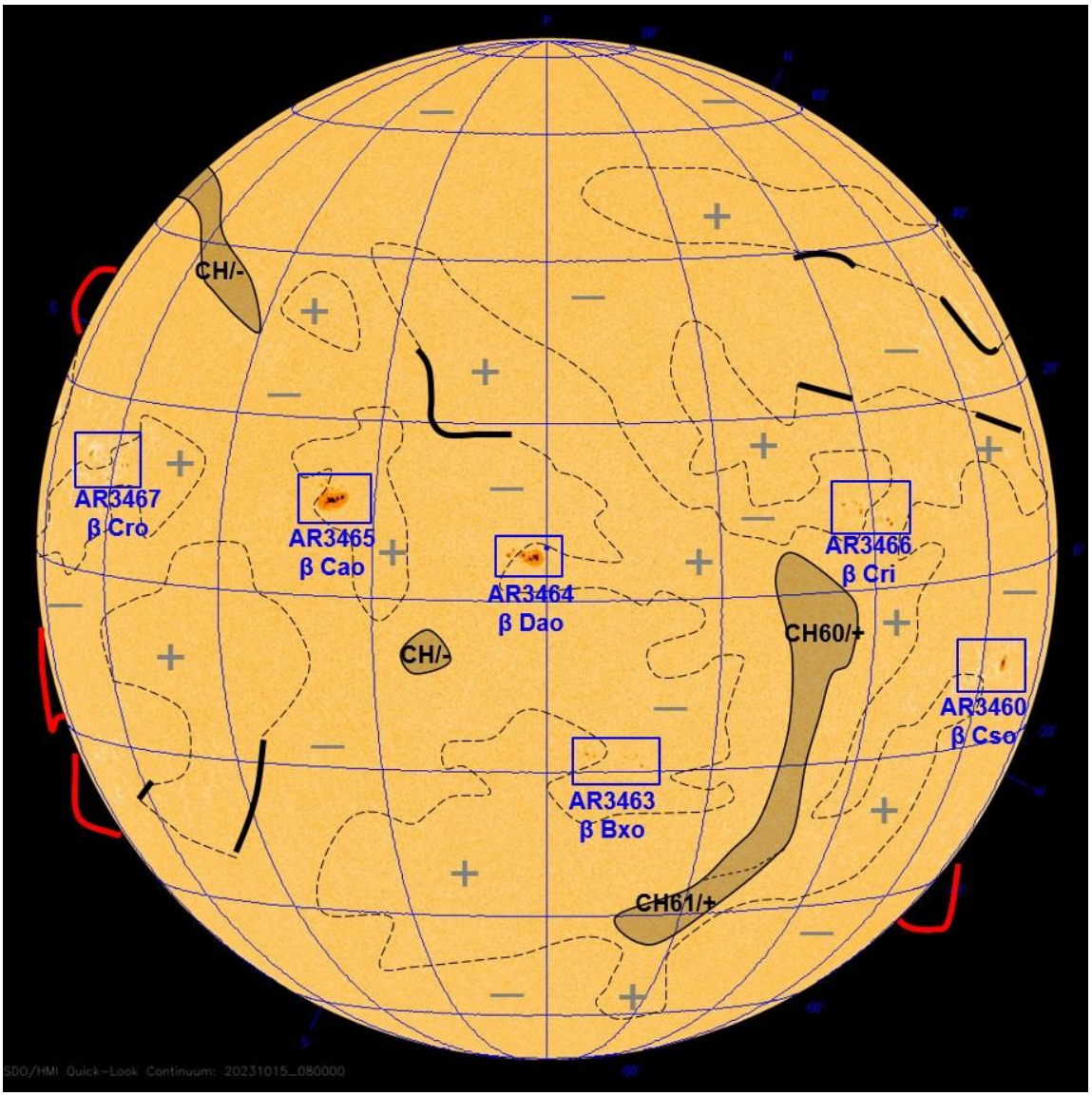
potential enhancement would be from the arrival of any fast wind from CH60/+, most likely later day 2-or early day 3 (16-17 Oct), although this is low confidence. Mainly Quiet geomagnetic activity is expected at first, but increasing to Unsettled to Active with a chance of G1 Minor Storms with any coronal hole fast wind connection or CME arrival, most likely day 2 or day 4 (16 or 18 Oct).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux will most likely remain at Background levels. High energy electron flux (greater than 2MeV) is expected to be mainly Background until after any fast wind enhancement from CH60/+. Flux then likely to increase to Moderate to peak High at times, with a chance of becoming more persistently High by day 4, although the potential for CME arrivals limits this. The associated 24 hour fluence is expected to remain below the Active threshold, with high confidence day 1-2 (15-16 Oct). There is an increasing chance of reaching the Active threshold day 3-4 (17-18 Oct).

Figure 1. Solar Analysis Valid 15/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The coronal hole forecast is low confidence with uncertainty around the potential for any influence of CH60/+ at Earth. This is a narrow southern disc feature extending from mid-latitudes to the solar equator. Despite this MOSWOC Enlil appears to show any High Speed Stream (HSS) fast wind missing well to the south of Earth, Furthermore the persistence-based forecast is contaminated by CME effects on the last rotation, limiting its guidance. Due to its positive polarity, however, any interaction with either the CIR (co-rotating interactivity region) ahead of this feature, or the onset of the HSS itself gives a likelihood of G1 Minor Storms, most likely late day 2 (16 Oct) or early day 3 (17 Oct).

There are also up to two CMEs with potential Earth-directed components. This first is from a corona-based dimming near N35W030 starting around 14/0340UTC. This has been modelled as delivering a possible glancing blow of Earth early day 4 (18 Oct). Secondly, a CME was observed from a dimming and subsequent EUV filament channel north of AR3466 at 14/1240UTC, around N15W25. Given a similar inbound speed and emission longitude, this CME may add to or very closely follow the above CME glance, reaching 1 AU, also on day 4 (18 Oct).

Overall, Quiet conditions day 1 and for much of day 2 (15-16 Oct) are likely to increase to Active to G1 Minor Storm later day 2 or early day 3 (16-17 Oct) if any coronal hole enhancement occurs, before easing to Quiet to Unsettled later day 3. Any CME arrival or arrivals day 4 (18 Oct) then brings a further chance of Active to G1 Minor Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	40	20	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1337	Partial	Filament	NW	448 km/s	Early 18 Oct	Low confidence, glance
14/2152	Partial	Filament	NW	431 km/s	Similar	Low confidence, glance. Likely combining with above.

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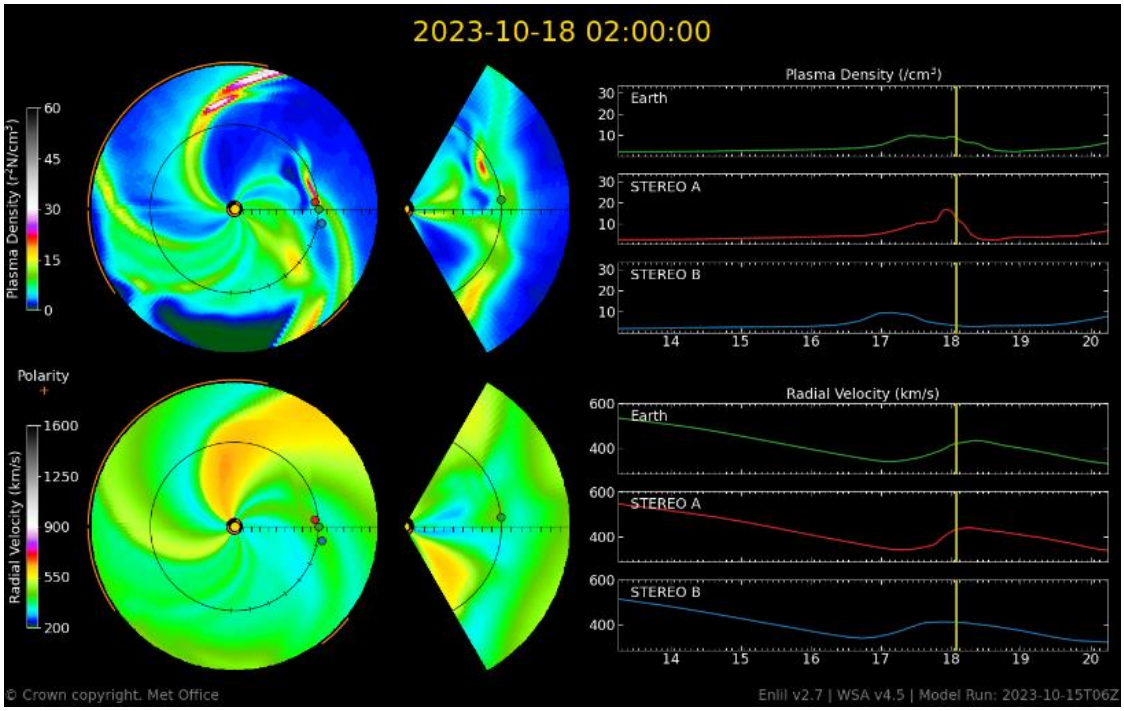
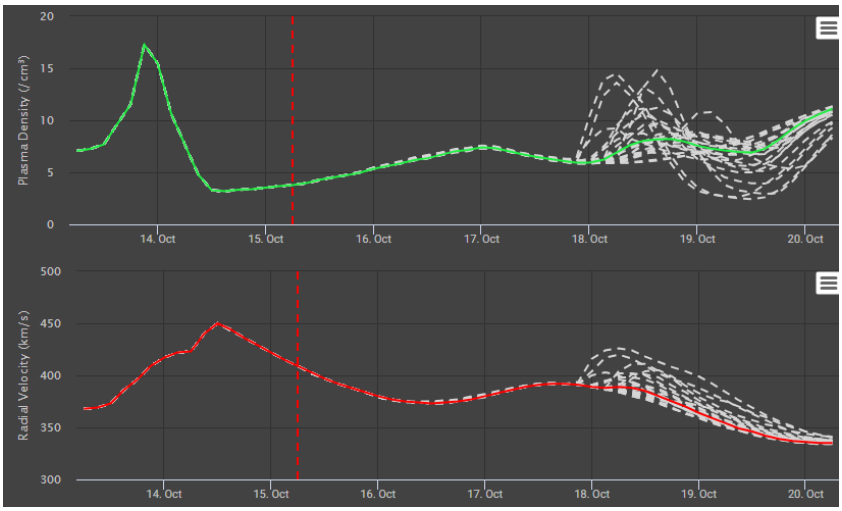
Figure 2: Enlil and Ensemble





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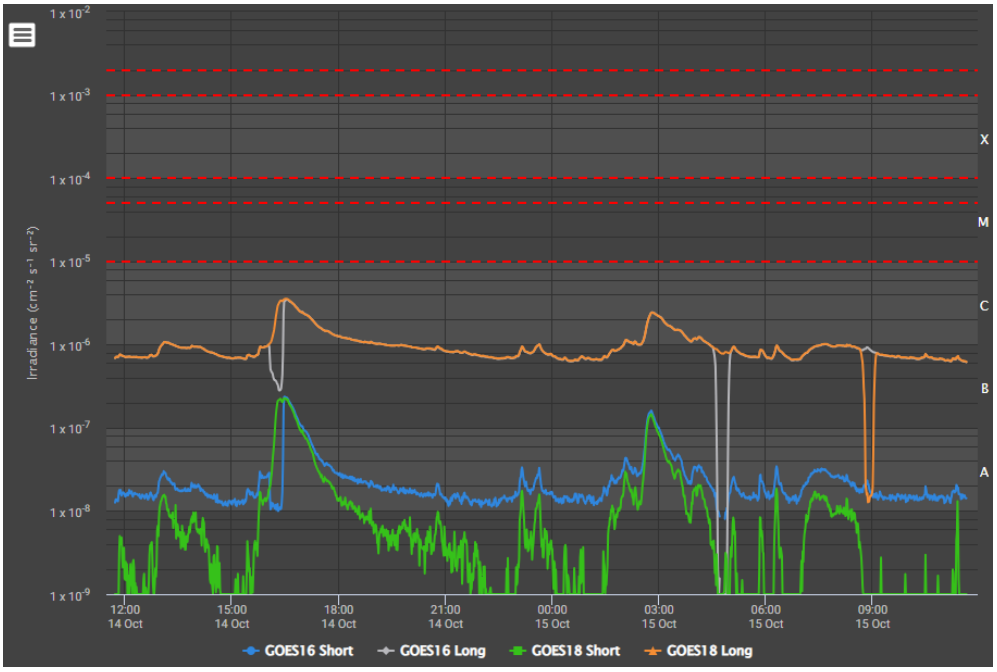
Radio Blackouts - X-Ray Flares:

Low activity is expected with only six small and relatively simple sunspots currently on the visible disc. The main potential for increasing activity is from AR3464 in the central disc, which has shown some slow development in the last 24 hours due to the emergence of a small trailer spot with penumbra. The other spots have remained mostly stable, with the strongest recent activity from the northeastern region AR3467. While a small region, this has some slightly increased complexity due to surrounding plage.

Activity has the potential to increase later in the period as any new regions rotate onto the disc, with an increasing chance of M-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	30	30	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels. Any increase to proton flux is unlikely, given the current visible disc sunspots.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux at GEO, as measured by GOES-16, is currently at background levels and expected to persist at this level day 1-2 (15-16 Oct). There is low confidence around the coronal hole forecast, with the extent of any enhancement from CH60/+ fast winds uncertain, however most likely on later day 2 or early day 3 (16-17 Oct). If this occurs, then the positive polarity of the coronal hole suggests a greater likelihood of being geoeffective, and a subsequent enhancement to high energy electron flux through the Van Allen belts. As any enhancement eases, this will increasingly be observed at GEO, with Moderate to High flux possible from late day 3 and day 4 (17-18 Oct). However a further complication is the potential for CME arrivals on day 4 (18 Oct) which may lead to a further reduction of the observed flux for a time.

The associated 24 hour fluence is high confidence for persisting below the Active threshold day 1-2 (15-16 Oct), but then has an increasing chance of rising above the Active threshold day 3-4 (17-18 Oct) depending upon the extent of the CH and CME enhancements. While this appears to be supported by REFM, the model forecast beyond T+24 is largely based on persistence from the previous 27-day which includes some CME contamination, further reducing confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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